REMARKS

This application is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000, which was filed in the German language, and which claimed the priority of German Application No. 19934179.6. Enclosed herewith please find a copy of the application translated into English as received from the translating party, entitled "Original Translation". Also enclosed please find a copy of the application as amended with additions underlined and deletions in brackets, which application is entitled "Version of Application with Markings to Show Changes Made". Finally, enclosed please find a clean copy of the application as amended, entitled "Clean Copy of Amended Application". Applicants enclose copies of the complete application to show the changes made and a clean copy of the complete application because under the new rules, we would have had to replace almost every paragraph in the application in this Preliminary Amendment. Applicants believe that no new subject matter has been added to the application.

Applicants respectfully that all amendments made herein be duly entered into the application. If there are any question, please contact applicants' undersigned attorney.

Conclusion

Based upon the above amendments and remarks, Applicants believe the pending claims of the above-captioned application are in allowable form and patentable. Applicants respectfully request consideration of the application as amended and a prompt Notice of Allowance thereon.

Applicants believe that no extension of time is necessary to file this Preliminary Amendment. Should Applicants be mistaken, Applicants respectfully request that the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this amendment timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Walter M. Douglas at (607) 974-2431.

Respectfully submitted,

CORNING INCORPORATED

Date: Jan 18, 2002

Date of Deposit: 1/19/02

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date indicated above with sufficient postage as first class mail in an envelope addressed to the: Commissioner of Patents and Trademarks, Washington, DC 20231

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CLEAN VERSION OF AMENDED APPLICATION

SI01-015

OPTICAL COUPLING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of German Patent Application No. 19934179.6, filed July 21, 1999, and is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000.

FIELD OF THE INVENTION

[0002] The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide.

BACKGROUND OF THE INVENTION

[0003] Coupling devices for cross-coupling light from a first optical waveguide into a second optical waveguide have been disclosed; for example in WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face by which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operations (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

[0004] In known coupling devices, the fibres are adhesively bonded into V grooves and the cavities which are produced in the process are filled with adhesive. Since the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element,

stresses may occur in the adhesive under changing environmental conditions, and therefore the fibres may go out of adjustment or alignment.

SUMMARY OF THE INVENTION

[0005] In one aspect, the invention provides an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip or planar waveguide) is achieved with high reliability and stability and cost-effective mounting. This is achieved by an optical coupling device having the features specified in Patent Claim 1.

[0006] One advantageous configuration of the coupling device according to the invention is that a ferrule is inserted into a hole in the variable-length element.

[0007] In the coupling device cited in the introduction, a first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

[0008] For this purpose, one advantageous configuration of the optical coupling device according to the invention is that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

[0009] This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that mal-adjustment in other dimensions virtually does not occur.

[0010] A further advantageous configuration of the device according to the invention is that the guide device has a ferrule which is connected to the variable-length element, and is mounted in a hole in the second holding block such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this

case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

[0011] A further advantageous configuration of the device according to the invention is that the guide device has a ferrule which is connected to the second holding block, and is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

[0012] In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule, which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

[0013] A further advantageous configuration of the device according to the invention is that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

[0014] A further advantageous configuration of the device according to the invention is that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

[0015] A further advantageous configuration of the device according to the invention is that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Exemplary embodiments of the invention will be explained below using the drawings, in which:

[0017] Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

[0018] Fig. 2 shows a side view of the device according to Fig. 1; and

[0019] Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

[0020] Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

[0021] Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0022] Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0023] Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] A rectangular, elongate, variable-length element 2, made of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

[0025] A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°, in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

[0026] Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

[0027] Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip (planar waveguide) in this example.

[0028] At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

[0029] In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second optical waveguide 50, an optical waveguide chip in this example.

[0030] Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

[0031] In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

[0032] At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore

engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

[0033] In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

[0034] Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.

1. Optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide, said device comprising:

   an elongate, variable length element which extends with its longitudinal direction parallel to the optical waveguide end faces, a first holding element, which is arranged at one longitudinal end of the variable-length element and is fixed there to a unit containing the second optical waveguide and on which the variable-length element is supported at the end, a second holding element which is arranged at the other longitudinal end of the variable-length element and is fixed there to the unit containing the second optical waveguide and supports the variable-length element at its other end with respect to the second optical waveguide, a linear guide device being provided on the second holding element, by means of which linear guide device the variable-length element is guided at its other end in such a way that it can lengthen substantially only in the direction of its longitudinal axis, and a ferrule, in which the first optical waveguide is held and which is held on the variable-length element at a point between the two holding elements, so that the relative position of the two optical waveguide end faces in relation to one another can be influenced with the aid of the variable-length element.

2. The device according to Claim 1, wherein the ferrule is inserted into a hole in the variable-length element.

3. The device according to Claim 1, wherein the guide device has a ferrule which is connected to the variable-length element and which is mounted in a hole in the second holding element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

4. The device according to Claim 3, wherein the ferrule is guided in the second holding element via a sleeve.

5. The device according to Claim 1, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the

variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

6. The device according to Claim 2, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

7. The device according to Claim 5, wherein the ferrule is guided in the variable-length element via a sleeve.

8. The device according to Claim 6, wherein the ferrule is guided in the variable-length element via a sleeve.

9. The device according to Claim 1, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

10. The device according to Claim 2, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

11. The device according to Claim 1, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

12. The device according to Claim 2, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

13. The device according to Claim 1, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

14. The device according to Claim 2, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

15. The device according to Claim 11, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

16. The device according to Claim 12, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

17. An optical coupling device for cross-coupling light between a first waveguide and a second waveguide, each having end faces, said device comprising:

a second planar waveguide having a first and a second holding block thereon,

a variable-length element having an opening therethrough for a ferrule or sleeve into which a first fibre waveguide may be placed and held, said variable-length element being movingly mounted on said first and second holding blocks in such a manner that the variable-length element is only longitudinally moveable parallel to the second waveguide, and

optionally, a fastening element on said second holding block whereby the position of the variable-length element may be secured;

wherein the end faces of said first and second waveguide are held by said coupling devices in facial contact with one another.

18. The device according to claim 17, wherein said variable-length element has a plurality of openings to thereby hold a plurality of first waveguides in facial contact with a second waveguide.

Abstract of the Invention

The optical coupling device serves to cross-couple light from a first into a second optical waveguide, a variable-length element influencing the relative position of the opposite end faces of the two optical waveguides in relation to one another. The element that fixes one of the two optical waveguides in a ferrule is connected by a first holding block to a unit containing the other optical waveguide. The said element has a guide device which engages in a second holding block and permits the element to lengthen substantially only in a spatial direction oriented parallel to the longitudinal axis of the element.

VERSION OF APPLICATION WITH MARKINGS TO SHOW CHANGES MADE

SI01-015

OPTICAL COUPLING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of German Patent Application No. 19934179.6, filed July 21, 1999, and is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000.

FIELD OF THE INVENTION

[0002] The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide. [Such a coupling device is known, for example, from WO 98/13718.]

BACKGROUND OF THE INVENTION

[0003] Coupling devices for cross-coupling light from a first optical waveguide into a second optical waveguide have been disclosed; for example in WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face by which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operations (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

[0004] In known coupling devices, the fibres are adhesively bonded into V grooves and [it] the cavities which are produced in the process are filled with adhesive. Since the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element,

stresses may occur in the adhesive under changing environmental conditions, and therefore [deadjustment of] the fibres may go out of adjustment or alignment.

SUMMARY OF THE INVENTION

[0005] [The object of] In one aspect, the invention [is to] provides an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip or planar waveguide) is achieved with high reliability and stability and cost-effective mounting. This [object] is achieved by an optical coupling device having the features specified in Patent Claim 1.

[0006] One advantageous configuration of the coupling device according to the invention is [characterized in] that [the] a ferrule is inserted into a hole in the variable-length element.

[0007] In the coupling device cited in the introduction, [the] a first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

[0008] For this purpose, one advantageous configuration of the optical coupling device according to the invention is [characterized in] that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

[0009] This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that [deadjustment] mal-adjustment in other dimensions virtually does not occur.

[0010] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device has a ferrule which is connected to the variable-length element, and [which] is mounted in a hole in the second holding block such that it can be

displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

[0011] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device has a ferrule which is connected to the second holding block, and [which] is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

[0012] In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule, which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

[0013] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

[0014] A further advantageous configuration of the device according to the invention is [characterized in] that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

[0015] A further advantageous configuration of the device according to the invention is [characterized in] that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Exemplary embodiments of the invention will be explained below using the drawings, in which:

[0017] Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

[0018] Fig. 2 shows a side view of the device according to Fig. 1; and

[0019] Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

[0020] Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

[0021] Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0022] Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0023] Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] A rectangular, elongate, variable-length element 2, [consisting] made of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

[0025] A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°, in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

[0026] Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

[0027] Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip (planar waveguide) in this example.

[0028] At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

[0029] In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second optical waveguide 50, an optical waveguide chip in this example.

[0030] Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

[0031] In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

[0032] At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore

engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

[0033] In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

[0034] Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.

DELETE WHOLE PAGE. SEE PCT AMENDED SHEETS FOR AMENDED CLAIMS

[Patent Claims]

[1. Optical coupling device for cross-coupling light from a first optical waveguide (20) into a second optical waveguide (30), it being possible to influence the relative position of the two optical waveguide end faces in relation to each other with the aid of a variable-length element (2, 26, 46, 66, 86) that holds the first optical waveguide (20) in a ferrule (6, 24, 44, 64, 84), and the variable-length element (2, 26, 46, 66, 86) being fixed to a unit containing the second optical waveguide (30) via a first holding element (4, 28, 48) and having a guide device (38, 40) which permits the element (2, 26, 46, 66, 86) to lengthen only in a spatial direction oriented substantially parallel to the longitudinal axis of the element.]

[2. Device according to Claim 1, characterized in that the ferrule (6, 24, 44, 64, 84) is inserted into a hole in the variable-length element (2, 26, 46, 66, 86).]

[3. Device according to one of the preceding claims, characterized in that the guide device has a second holding element (40, 58, 74) as an abutment, on which the variable-length element (26, 46, 66, 86) is guided parallel to the expansion direction of the variable-length element.]

[4. Device according to Claim 3, characterized in that the guide device has a ferrule (36) which is connected to the variable-length element (26) and which is mounted in a hole in the second holding element (40) such that it can be displaced in the direction of the axis of the variable-length element (26) in which the variation in length takes place.]

[5. Device according to Claim 4, characterized in that the ferrule is guided in the second holding element (40) via a sleeve (38).]

[6. Device according to Claim 3, characterized in that the guide device has a ferrule which is connected to the second holding element (40) and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.]

[7. Device according to Claim 6, characterized in that the ferrule is guided in the variable-length element via a sleeve.]

[8. Device according to Claim 3, characterized in that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element (58).]

[9. Device according to Claim 3, characterized in that the second holding block (74) has a U-shaped cross section, and in that the variable-length element (56) is guided in the U-shaped cross section of the second holding element (74).]

[10. Device according to Claim 3, characterized in that an abutment (92), which engages on the second optical waveguide in a displaceable manner, is fixed to the variable-length element (86).]

[11. Device according to Claim 8, characterized in that the abutment has on one side a spring (96) between one end of the abutment and the second optical waveguide (90) and on the other side a setting screw (100) between another end of the abutment and the second optical waveguide (90).]

Patent Claims PCT Amended Sheets

1. Optical coupling device for cross-coupling light from a first optical waveguide [(20, 42, 62, 82)] into a second optical waveguide [(30, 50, 70, 90)], [having] said device comprising:

an elongate, variable length element [(26, 46, 66, 86)] which extends with its longitudinal direction parallel to the optical waveguide end faces, a first holding element [(28, 48, 68, 88)], which is arranged at one longitudinal end of the variable-length element [(26, 46, 66, 86)] and is fixed there to a unit containing the second optical waveguide [(30, 50, 70, 90)] and on which the variable-length element [(26, 46, 66, 86)] is supported at the end, a second holding element [(40, 58, 74, 92)] which is arranged at the other longitudinal end of the variable-length element [(26, 46, 66, 86)] and is fixed there to the unit containing the second optical waveguide [(30, 50, 70, 90)] and supports the variable-length element [(26, 46, 66, 86)] at its other end with respect to the second optical waveguide [(30, 50, 70, 90)], a linear guide device being provided on the second holding element [(40, 58, 74, 92)], by means of which linear guide device the variable-length element [(26, 46, 66, 86)] is guided at its other end in such a way that it can lengthen substantially only in the direction of its longitudinal axis, and a ferrule [(24, 44, 64, 84)], in which the first optical waveguide [(20, 42, 62, 82)] is held and which is held on the variable-length element [(26, 46, 66, 86)] at a point between the two holding elements [(28, 48, 68, 88; 40, 58, 74, 92)], so that the relative position of the two optical waveguide end faces in relation to one another can be influenced with the aid of the variable-length element [(26, 46, 66, 86)].

2. [Device] The device according to Claim 1, [characterized in that] wherein the ferrule [(24, 44, 64, 84)] is inserted into a hole in the variable-length element [(26, 46, 66, 86)].

3. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device has a ferrule [(36)] which is connected to the variable-length element [(26)] and which is mounted in a hole in the second holding element [(40)] such that it

can be displaced in the direction of the axis of the variable-length element [(26)] in which the variation in length takes place.

4. [Device] The device according to Claim 3, [characterized in that] wherein the ferrule is guided in the second holding element [(40)] via a sleeve [(38)].

5. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device has a ferrule which is connected to the second holding element [(40)] and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

6. The device according to Claim 2, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

7. [Device] The device according to Claim 5, [characterized in that] wherein the ferrule is guided in the variable-length element via a sleeve.

8. The device according to Claim 6, wherein the ferrule is guided in the variable-length element via a sleeve.

9. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element [(58)].

10. The device according to Claim 2, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

11. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the second holding element [(74)] has a U-shaped cross section, and in that the variable-length element [(56)] is guided in the U-shaped cross section of the second holding element [(74)].

12. The device according to Claim 2, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

13. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the variable-length element [(86)] is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

14. The device according to Claim 2, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

15. [Device] The device according to Claim [8] 11, [characterized in that] wherein the second holding element has, on one side, a spring [(96)] between its end and the second optical waveguide [(90)] and, on the other side, a setting screw [(100)] between its other end and the second optical waveguide [(90)].

16. The device according to Claim 12, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

17. An optical coupling device for cross-coupling light between a first waveguide and a second waveguide, each having end faces, said device comprising:

a second planar waveguide having a first and a second holding block thereon,

a variable-length element having an opening therethrough for a ferrule or sleeve into which a first fibre waveguide may be placed and held, said variable-length element being

movingly mounted on said first and second holding blocks in such a manner that the variable-length element is only longitudinally moveable parallel to the second waveguide, and

optionally, a fastening element on said second holding block whereby the position of the variable-length element may be secured;

wherein the end faces of said first and second waveguide are held by said coupling devices in facial contact with one another.

18. The device according to claim 17, wherein said variable-length element has a plurality of openings to thereby hold a plurality of first waveguides in facial contact with a second waveguide.

Abstract of the Invention

[Optical coupling device]

The optical coupling device serves to cross-couple light from a first into a second optical waveguide [(20, 30)], a variable-length element [(26)] influencing the relative position of the opposite end faces of the two optical waveguides [(20, 30)] in relation to one another. The element [(26)] that fixes one of the two optical waveguides [(20)] in a ferrule [(24)] is connected by a first holding block [(28)] to a unit containing the other optical waveguide [(30)]. The said element has a guide device [(34, 36)] which engages in a second holding block [(38, 40)] and permits the element [(26)] to lengthen substantially only in a spatial direction oriented parallel to the longitudinal axis of the element.

[Figure 4]